

**SQUEEZABLE CONTAINER AND METHOD OF MANUFACTURE**

The present invention is directed to containers of a type adapted to be radially compressed or squeezed by a user to dispense product from the container, and to a method of making such a the container.

**Background and Summary of the Invention**

5 It is a general object of the present invention to provide a container with a body of blow-molded plastic construction, and a method of making such a container, having a sidewall that is contoured and constructed to be readily ergonomically squeezable for maximizing the dispensing of either hot-filled, or cold-filled liquid product.

10 A plastic container in accordance with one aspect of the present invention includes a finish, a shoulder extending from the finish, a closed base, and a sidewall connecting the shoulder to the base. The sidewall is of blow molded construction and generally uniform wall thickness. The sidewall has an array of circumferentially spaced longitudinally extending radially recessed channels, and an array of axially spaced circumferentially extending radially recessed channels intersecting the longitudinally extending channels. The longitudinally extending channels have radially inner  
15 portions that lie on an hourglass-shaped common surface of revolution around the axis of the container sidewall. In accordance with a second aspect of the preferred embodiments of the invention, a plurality of axially and circumferentially spaced land areas are disposed in spaces between the intersecting longitudinally and circumferentially extending channels, with the land areas lying on a common surface of revolution, preferably a cylindrical surface of revolution, around the  
20 axis of the container sidewall.

### **Brief Description of the Drawings**

The invention, together with additional objects, features, advantages and aspects thereof, will be best understood from the following description, the appended claims and the accompanying drawings, in which:

5                   FIG. 1 is a side elevational view of a container in accordance with one exemplary embodiment of the invention;

                  FIGS. 2 and 3 are sectional views taken substantially along the respective lines 2-2 and 3-3 in FIG. 1;

                  FIG. 4 is a fragmentary sectional view taken substantially along the line 4-4 in FIG.  
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                  FIG. 5 is a side elevational view of a container in accordance with a second exemplary embodiment of the invention;

                  FIGS. 6 and 7 are sectional views taken substantially along the respective lines 6-6 and 7-7 in FIG. 5; and

15               FIGS. 8A and 8B are schematic illustrations of respective alternative hourglass-shaped surfaces of revolution.

### **Detailed Description of Preferred Embodiments**

                  FIGS. 1-4 illustrate a one-piece integrally molded container 10 in accordance with one presently preferred embodiment of the invention. Container 10 preferably includes a finish 12,  
20               which preferably has one or more external threads or beads 14 for securing a dispensing closure to the container finish. A container body 16 preferably includes a shoulder or dome 18 that extends from the lower end of finish 12. (Direction words such as “upper” and “lower” are employed by way

of description and not limitation with respect to the upright orientation of the containers illustrated in FIGS. 1, 4 and 5. Directional words such as “axial” and “radial” are employed by way of description and not limitation with respect to the axis of the container sidewall, which preferably although not necessarily is concentric with the axes of the container finish, shoulder and base.) A container sidewall 20 interconnects the lower edge of shoulder 18 with a closed container base or bottom 22. Finish 12, shoulder 16 and base 22 may be of any suitable construction, with the geometries illustrated in the drawings being exemplary. The present invention deals primarily with the construction of container sidewall 20.

Referring to FIGS. 1-4, container sidewall 20 includes a plurality of arcuate land areas 24 defined between a plurality of longitudinally extending circumferentially spaced radially inwardly recessed container sidewall grooves or channels 26a-26g, and a plurality of axially spaced continuous circumferentially extending radially inwardly recessed container sidewall grooves or channels 28a-28d. Land areas 24 preferably are rectangular as viewed in side elevation (FIG. 1), and have outer surfaces that lie on a common surface of revolution 32 around an axis 30 (FIGS. 3 and 4) of container sidewall 20, preferably a cylindrical surface of revolution. (Reference to a “common” surface of revolution means that all of the referenced structures, in this case the outer surfaces of land areas 24, lie on a single shared surface of revolution.) Longitudinal channels 26a-26g and circumferential channels 28a-28d cross or intersect at surface of resolution 32 to form land areas 24.

Longitudinally extending circumferentially spaced channels 26a-26g preferably are identical to each other and uniformly angularly spaced around sidewall axis 30. As best seen in FIG. 4, the radially inner portions of the several longitudinal channels 26a-26g lie on an hourglass-shaped common surface of revolution 33 around sidewall axis 30. This surface of revolution curves

continuously in the preferred embodiments of the invention from the upper end of sidewall 20 where the sidewall connects with shoulder 18 to the lower end of sidewall 20 where the sidewall connects with container base 22. The minimum diameter or waist of hourglass-shaped surface of revolution 33 preferably is about halfway between the upper and lower ends of the sidewall, although this can vary for containers of differing geometries. Hourglass-shaped surface of revolution 33 can have other than continuously curving geometries, such as a geometry in which the upper and lower end portions are substantially conical and are interconnected by a curved waist. The outline of the hourglass-shaped geometry can be symmetrical or non-symmetrical, such as by placing the waist well above or below the midpoint of the sidewall. The preferred embodiment illustrated in FIG. 4 is slightly asymmetrical in that, while the mid portion of surface 33 is at constant radius, the upper and lower end portions are at differing non-constant radii. As viewed from the axial direction (FIGS. 2 and 3), longitudinal channels 26a-26g may be of any suitable geometry, such as substantially V-shaped as shown in the drawings, or curving at either constant or varying radius of curvature. The radially inner portions of longitudinal channels 26a-26g may be sharp or have small radii of curvature, or more preferably may possess large radii of curvature or even be substantially flat. Longitudinal channels 26a-26g are uniformly spaced from to each other, and may be at an angle to sidewall axis 30 of 0° to 30°. In the preferred embodiments illustrated in the drawings, longitudinal channels 26a-26g (or 26a-26h in FIGS. 5-7) are identical, parallel to each other and parallel to sidewall axis 30.

Circumferentially extending channels 28a-28d have central planes that are parallel to each other and perpendicular to sidewall axis 30. Channels 28a-28d preferably have identical uniform radii of curvature R (FIG. 4). The radial depth of channels 28a-28d vary with axial position

along sidewall 20, as best seen in FIG. 1, and as a function of the depth of the longitudinal channels 26a-26g. That is, circumferential channels 28a-28d have a radial depth that is equal to or, preferably, slightly less than the radial depth of the longitudinal channels at the axial position of each circumferential channel. Thus, as best seen in FIG 1, circumferentially extending channel 28a has the least radial depth and axial dimension, while circumferentially extending channel 28c has the greatest radial depth and axial dimension. As noted above, and as best seen in FIG. 2, the radial depth of circumferential channels 28a-28d preferably is slightly less than the radial depth of longitudinal channels 26a-26g. FIGS. 8A and 8B are schematic drawings of respective exemplary alternative hourglass-shaped surfaces of revolution 33a and 33b.

Circumferential channels 28a-28d (or 28a-28e in FIG. 5) preferably have identical uniform radii of curvature R as noted above. However, these channels can be non-identical and/or have other than uniform radii of curvature, such as V-shaped channels. Container sidewall 20 preferably, but not necessarily, is separated from shoulder 18 by a continuous circumferentially extending channel 34 (FIG. 1), and from base 22 by a continuous circumferentially extending channel 36. Channels 34, 36 help isolate sidewall 20, which is designed for squeeze-dispensing of product from the container, from shoulder 18 and base 22 that are less flexible and squeezable.

FIGS. 5-7 illustrate a container 40 in accordance with a second exemplary embodiment of the invention. Reference numerals in FIGS. 5-7 that are identical to those in FIGS. 1-4 indicate related elements. Container 40 has a sidewall 42 that extends between a shoulder 44 and a base 46. Sidewall 42 is similar to sidewall 20 in FIGS. 1-4, except that there are six longitudinally extending circumferentially spaced channels 26a-26h, and five circumferentially continuous axially spaced channels 28a-28e. The geometries of and relationships between the

longitudinally extending and circumferentially extending channels in the embodiment of FIGS. 5-7 are the same as in the embodiment of FIGS. 1-4.

As noted above, surface of revolution 32 (FIGS. 3 and 4), on which land areas 24 lie, preferably is cylindrical around axis 30. However, surface of revolution 32 may have other geometries, such as hourglass-shaped or barrel-shaped. Indeed, surface of revolution 32 may be wavy as viewed in longitudinal cross section (FIG. 4). It is preferred that all land areas 24 at a given axial position be at the same radius, which is to say that the land areas preferably lie in a single common surface of revolution around axis 30.

A further common surface of revolution 48 (FIG. 4) preferably is defined by the inner portions of circumferential channels 28a-28d (or 28a-28e in FIG. 5). Surface of revolution 48 preferably is hourglass-shaped, and preferably closely tracks and is spaced radially outwardly from surface of revolution 33. However, surface of revolution 48 might contact surface of revolution 33, and indeed may be congruent with surface of revolution 33. Furthermore, surface of revolution 48 may be non-hourglass-shaped if desired.

Containers and sidewalls in accordance with the present invention can be fabricated by any suitable blow molding technique. The containers preferably are fabricated in a two stage operation by blow molding preforms, which are themselves injection or compression molded. The containers alternatively can be formed in a single stage injection stretch blow molding operation, or in an injection extrusion blow molding operation in which the finish is injection molded and a tube is extruded from the finish and blow molded to form the container body. In molding operations of these types, the container finish typically is injection or compression molded to its final configuration and is of relatively rigid construction, while the container body is blow molded after the finish is

formed. The container also can be formed in an extrusion blow molding operation. Other container molding operations can be employed. For example, finish 12 with external threads 14 can be attached to the container body after blow molding the container body.

The container of the present invention can be of any suitable plastic construction, such as monolayer or multilayer polyester, polyethylene (e.g., HDPE) or polypropylene (PP). The containers preferably are of monolayer or multilayer polyethylene terephthalate (PET) construction. In multilayer containers, one or more intermediate layers are provided between inner and outer layers of PET construction, such as intermediate layers of active or passive barrier material (e.g., nylon or ethylene vinyl alcohol (EVOH)) to retard migration of gases through the container wall. The barrier layers may or may not extend into the finish of the container. The radial thickness of sidewall 20 or 42 preferably is substantially uniform around the sidewall - i.e., ignoring the slight thickness differences that result from differential expansion of the container sidewall during blow molding. In one current embodiment of the container illustrated in FIGS. 1-4, the wall thickness is 0.012 inch at the insides of longitudinally extending channels 26a-26g and 0.008 inch at land areas 24. In other words, there is a 0.004 inch difference in wall thicknesses in this example due to differential expansion of the sidewall material. The radial thickness of sidewall 20 or 42 preferably is substantially uniform and in the range of 0.005 to 0.03 inch. In an exemplary embodiment shown substantially to scale in FIGS. 1-4, sidewall 20 has a height of about 3.9 inches between channels 34, 36, radius R is about 0.6 inch. The radius of curvature of the mid portion of surface 33 is about eleven to twelve inches, and varies at the upper and lower ends as noted above.

After blow molding, container 10 or 40 is filled with liquid product and a dispensing closure is applied to container finish 12. A suitable slide-nozzle dispensing closure, for example,

is illustrated in U.S. Patent 5,303,834. To dispense product from the container, container sidewall 20 or 42 is gripped by a user, and is deformed or squeezed radially inwardly to increase the pressure within the container and thereby dispense product through the dispensing closure. Container sidewall 20 or 42 in accordance with the present invention is specifically contoured to be extremely squeezable for maximizing the dispensing of liquid from the container. When sidewall 20 or 42 is grasped by a user, the fingers of the user's hand naturally nestle within circumferentially extending channels 28a-28d or 28a-28e. The bases of longitudinally extending channels 26a to 26g or 26h naturally form lines of flexure during squeezing of the container sidewall. The portions of the container sidewall between longitudinally extending channels 26a-26g or 26h form vertical columns that provide top load strength to the container body. The container wall thus may be of reduced thickness without sacrificing either top load capability or squeeze-fatigue strength.

The container of the present invention is adapted for both cold-fill and hot-fill applications. In hot-fill applications, in which the container is filled with hot liquid product and then capped, an internal vacuum develops as the product cools. Container sidewall 20 or 42 may distort under the vacuum pressure within the container. The container sidewall may assume an oval geometry, or a triangular geometry with the corners of the triangle being randomly located at longitudinally extending channels 26a-26g or 26h. However, the fingers of a user will still naturally nestle within circumferential channels 28a-28d or 28e, so that the container can be readily squeezed to dispense product. Thus, the ergonomic wrap-around grip design of sidewalls 20, 42 is maintained in both hot-fill and cold-fill applications. Furthermore, in hot-fill applications, the contour of container sidewalls 20, 42 channels the vacuum forces around the container sidewall rather than



attempting to provide sufficient resistance to prevent deformation, or to provide localized areas or panels for deformation, which reduces both the cost and the complexity of the sidewall design.

There have thus been disclosed a container, a container sidewall and a method of making a container that fully satisfy all of the objects and aims previously set forth. The invention has been disclosed in connection with two presently preferred embodiments thereof, and a number of modifications and variations have been discussed. Other modifications and variations will readily suggest themselves to persons of ordinary skill in the art. The invention is intended to embrace all such modifications and variations as fall within the spirit and broad scope of the appended claims.